Package 'etrm'

October 13, 2022

Type Package

Title Energy Trading and Risk Management

Version 1.0.1

Date 2021-06-22

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Description Provides a collection of functions to perform core tasks within
Energy Trading and Risk Management (ETRM). Calculation of maximum smoothness
forward price curves for electricity and natural gas contracts with flow delivery, as presented in
F. E. Benth, S. Koekebakker, and F. Ollmar (2007) <doi:10.3905/jod.2007.694791>
and F. E. Benth, J. S. Benth, and S. Koekebakker (2008) <doi:10.1142/6811>.
Portfolio insurance trading strategies for price risk management in the forward market, see
F. Black (1976) <doi:10.1016/0304-405X(76)90024-6>,
T. Bjork (2009) <https://EconPapers.repec.org/RePEc:oxp:obooks:9780199574742>,
F. Black and R. W. Jones (1987) <doi:10.3905/jpm.1987.409131> and
H. E. Leland (1980) <http://www.jstor.org/stable/2327419>.

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Encoding UTF-8

LazyData TRUE

RoxygenNote 7.1.1

Imports ggplot2, reshape2, methods

Suggests testthat, knitr, rmarkdown, markdown

VignetteBuilder knitr

Depends R (>= 3.5.0)

NeedsCompilation no

Repository CRAN

Date/Publication 2021-06-23 07:30:05 UTC

R topics documented:

`etrm-package` *etrm: Energy Trading and Risk Management*

Description

Tools for energy market risk management (forward curves and trading strategies)

Author(s)

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References

F. E. Benth, S. Koekkebakker, and F. Ollmar. Extracting and applying smooth forward curves from average-based commodity contracts with seasonal variation.The Journal of Derivatives, 15(1):52–66,2007b. https://doi.org/10.3905/jod.2007.694791

F. E. Benth, J. S. Benth, and S. Koekebakker. Stochastic modelling of electricity and related markets,volume 11. World Scientific, 2008. https://doi.org/10.1142/6811

F. Black. The pricing of commodity contracts.Journal of financial economics, 3(1):167–179, 1976. https://doi.org/10.1016/0304-405X(76)90024-6

T. Bjork. Arbitrage Theory in Continuous Time. Oxford University Press, 3 edition, 2009. https://EconPapers.repec.org/RePE

F. Black and R. W. Jones. Simplifying portfolio insurance. The Journal of Portfolio Management, 14(1):48–51, 1987. https://doi.org/10.3905/jpm.1987.409131

H. E. Leland. Who should buy portfolio insurance? The Journal of Finance, 35(2):581–594, 1980. http://www.jstor.org/stable/2327419

`cppi` *Constant Proportion Portfolio Insurance (CPPI)*

Description

Implements CPPI strategy for commodity price risk management

Usage

```
cppi(q, tdate, f, tper, rper, tcost = 0, int = TRUE)
```

Arguments

`q`	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
`tdate`	date vector with trading days
`f`	numeric futures price vector
`tper`	numeric target price markup/down to the price on the first trading day
`rper`	numeric risk factor as a percentage of the price on the first trading day
`tcost`	numeric transaction costs pr unit
`int`	TRUE/FALSE integer restriction on tradable volume

Value

instance of the CPPI class

Examples

```
# CPPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
```

```
t <- seq (0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum ( sqrt(delta) * rnorm (N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

# implement cppi strategy for buyer
cppi_b <- cppi(q = 10,
tdate = tr_dates,
f = f_gbm,
tper = 0.1,
rper = 0.1,
tcost = 0,
int = TRUE)

# implement cppi strategy for seller
cppi_s <- cppi(q = - 10,
tdate = tr_dates,
f = f_gbm,
tper = - 0.1,
rper = 0.1,
tcost = 0,
int = TRUE)
```

`CPPI-class` *An S4 class for the CPPI hedging strategy*

Description

An S4 class for the CPPI hedging strategy

Slots

`RiskFactor` The risk factor (cushion) used in the CPPI model

`dppi` *Dynamic Proportion Portfolio Insurance (DPPI)*

Description

Implements DPPI strategy for commodity price risk management

Usage

```
dppi(q, tdate, f, tper, rper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
tper	numeric target price factor, markup/down to the price on the first trading day
rper	numeric risk factor as a percentage of the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the DPPI class

Examples

```
# DPPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq (0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum ( sqrt(delta) * rnorm (N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

# implement dppi strategy for buyer
dppi_b <- dppi(q = 10,
tdate = tr_dates,
f = f_gbm,
tper = 0.1,
rper = 0.1,
tcost = 0,
int = TRUE)

# implement dppi strategy for seller
dppi_s <- dppi(q = - 10,
tdate = tr_dates,
f = f_gbm,
tper = - 0.1,
```

```
rper = 0.1,
tcost = 0,
int = TRUE)
```

DPPI-class *An S4 class for the DPPI hedging strategy*

Description

An S4 class for the DPPI hedging strategy

Slots

`TargetPercent` A percentage of first trading day's market price used to set target price (cap or floor)

`RiskFactor` The risk factor (cushion) used in the DPPI model

GenericStrat-class *An S4 VIRTUAL parent class for the hedging strategy classes in etrm*

Description

An S4 VIRTUAL parent class for the hedging strategy classes in etrm

Slots

`Name` A string with the portfolio insurance strategy name

`Volume` The quantity to be hedged

`TargetPrice` The target price(s) for the portfolio (cap or floor)

`TransCost` Transaction costs pr unit traded

`TradeisInt` TUE/FALSE integer restriction on tradable volume, TRUE sets smallest transacted unit to 1

`Results` Data frame with strategy results, daily values for market price, transactions, exposure, position, hedge and portfolio price

msfc *Maximum Smoothness Forward Curve (MSFC)*

Description

Creates a smooth forward curve from futures prices for a flow delivery

Usage

```
msfc(tdate, include, contract, sdate, edate, f, prior = 0)
```

Arguments

tdate	trading date
include	logical vector to determine if contracts should be included in calculation
contract	vector with contract names
sdate	date vector with contract delivery start dates
edate	date vector with contract delivery end dates
f	numeric vector with futures contract prices
prior	numeric vector with prior forward price curve

Value

instance of the MSFC class

Examples

```
# calculate forward curve for synthetic futures contracts, without prior

# date for curve calculation and contract information
tdate <- as.Date("2021-06-17")
include <- rep(TRUE, 10)
contract <- c("JUL-21", "AUG-21", "SEP-21", "OCT-21", "NOV-21", "DEC-21",
"Q1-22", "Q2-22", "Q3-22", "Q4-22")

sdate <- as.Date(c("2021-07-01", "2021-08-01", "2021-09-01", "2021-10-01",
"2021-11-01", "2021-12-01", "2022-01-01", "2022-04-01", "2022-07-01", "2022-10-01"))

edate <- as.Date(c("2021-07-30", "2021-08-31", "2021-09-30", "2021-10-31",
"2021-11-30", "2021-12-31", "2022-03-31", "2022-06-30", "2022-09-30", "2022-12-31"))

f <- c(32.55, 32.50, 32.50, 32.08, 36.88, 39.80, 39.40, 25.20, 21.15, 29.50)

fwd_curve <- msfc(tdate = tdate,
include = include,
contract = contract,
sdate = sdate,
edate = edate,
f = f)
```

MSFC-class *An S4 class for the Maximum Smoothness Forward Curve (MSFC) in etrm*

Description

An S4 class for the Maximum Smoothness Forward Curve (MSFC) in etrm

Slots

`Name` A string with the acronym for Maximum Smoothness Forward Curve, "MSFC"

`TradeDate` The trading date

`BenchSheet` A data frame with futures contracts selected for calculation with MSFC computed prices

`Polynomials` The number of polynomials in the MSFC spline

`PriorFunc` A numeric vector with the prior function values

`Results` A data frame with daily values for the calculated MSFC and contracts in "BenchSheet"

`SplineCoef` List with coefficients for the polynomials in the MSFC spline

`KnotPoints` Vector with spline knot points

`CalcDat` Data frame extending "Results" with daily values for time vectors and polynomial coefficients used in calculation

obpi *Option Based Portfolio Insurance (OBPI)*

Description

Implements OBPI strategy for commodity price risk management

Usage

```
obpi(
  q,
  tdate,
  f,
  k = f[1],
  vol,
  r = 0,
  tdays = 250,
  daysleft,
  tcost = 0,
  int = TRUE
)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
k	numeric value for option strike price
vol	value for volatility
r	value for interest rate
tdays	integer assumed number of trading days per year
daysleft	integer with days left to option expiry
tcost	numeric transaction costs pr unit
int	TRUE/ FALSE integer restriction on tradable volume

Value

instance of the OBPI class

Examples

```
# OBPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq (0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum ( sqrt(delta) * rnorm (N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

#implement obpi strategy for buyer
obpi_b <- obpi(q = 10,
tdate = tr_dates,
f = f_gbm,
k = f_gbm[1],
vol = 0.2,
r =  0,
tdays = 250,
daysleft = length(f_gbm),
tcost = 0,
```

```
int = TRUE)

# implement obpi strategy for seller
obpi_s <- obpi(q = - 10,
tdate = tr_dates,
f = f_gbm,
k = f_gbm[1],
vol = 0.2,
r =  0,
tdays = 250,
daysleft = length(f_gbm),
tcost = 0,
int = TRUE)
```

`OBPI-class` *An S4 class for the OBPI hedging strategy*

Description

An S4 class for the OBPI hedging strategy

Slots

`StrikePrice` Strike price for the synthetic option hedging

`AnnVol` Annualized volatility for the contract to be traded

`InterestRate` Risk-free rate of interest

`TradingDays` The number of trading days per year

`plot,GenericStrat-method`
S4 method for the plot generic for portfolio insurance strategy classes

---

Description

S4 method for the plot generic for portfolio insurance strategy classes

Usage

```
## S4 method for signature 'GenericStrat'
plot(
  x,
  y = NULL,
  title = "Strategy plot",
  xlab = "",
```

```
  ylab.1 = "Price",
  ylab.2 = "Hedge %",
  pcols = c("#F8766D", "steelblue3", "gray60", "gray80"),
  legend = "bottom"
)
```

Arguments

x	instance of the strategy class created by the corresponding strategy function
y	NULL
title	plot title
xlab	label for x-axis
ylab.1	label for y-axis on price plot in top panel
ylab.2	label for y-axis on hedge plot in bottom panel
pcols	vector with four color codes for plot
legend	legend position in c("top", "bottom")

Value

a two-panel chart with daily values for (top panel) target price, market price and portfolio price and (bottom) portfolio hedge rate

---

plot,MSFC-method *S4 method for the plot generic for class "MSFC"*

Description

S4 method for the plot generic for class "MSFC"

Usage

```
## S4 method for signature 'MSFC'
plot(
  x,
  y = NULL,
  plot.prior = FALSE,
  title = "",
  xlab = "",
  ylab = "Price",
  legend = "right"
)
```

Arguments

x	instance of the MSFC class created by the msfc function
y	NULL
plot.prior	TRUE/FALSE for incuding prior function in plot
title	plot title
xlab	x-axis title
ylab	y-axis title
legend	position of legend, as implemented in ggplot2

Value

a chart with daily values for the forward curve and contracts used in calculation

---

powcal *Historical daily closing prices for 11 calendar year power futures contracts*

Description

A synthetic dataset containing the closing prices and other attributes of 11 power futures contracts for calendar year delivery for 2006 - 2016.

Usage

```
powcal
```

Format

A data frame with 3253 rows and 12 columns:

Date the trading date

CAL-06 the closing price for the 2006 futures contract

CAL-07 the closing price for the 2007 futures contract

CAL-08 the closing price for the 2008 futures contract

CAL-09 the closing price for the 2009 futures contract

CAL-10 the closing price for the 2010 futures contract

CAL-11 the closing price for the 2011 futures contract

CAL-12 the closing price for the 2012 futures contract

CAL-13 the closing price for the 2013 futures contract

CAL-14 the closing price for the 2014 futures contract

CAL-15 the closing price for the 2015 futures contract

CAL-16 the closing price for the 2016 futures contract

powfutures130513 *Closing prices for power futures contracts at trading date 2013-05-13*

Description

A synthetic dataset containing the closing prices and other attributes of 38 power futures contracts.

Usage

```
powfutures130513
```

Format

A data frame with 38 rows and 5 columns:

Include boolean variable to determine if contract should be included in forward curve calculation

Contract the name of the futures contract

Start delivery start date for the futures contract

End delivery start date for the futures contract

Closing the futures contract closing price

powpriors130513 *Example priors at trading date 2015-05-13*

Description

An example of two simple priors for forward market price to be used with powfutures130513

Usage

```
powpriors130513
```

Format

A data frame with 3885 rows and 3 columns:

Date vector of dates ranging from 2013-05-13 to final end date of contracts in powfutures130513

trig.prior a simple smooth trigonometric prior describing power price seasonality

mod.prior a trigonometric prior adjusted for typical calendar effects

show,GenericStrat-method *S4 method for the show generic for portfolio insurance strategy classes*

Description

S4 method for the show generic for portfolio insurance strategy classes

Usage

```
## S4 method for signature 'GenericStrat'
show(object)
```

Arguments

object	instance of a strategy class

Value

a data frame with daily observations for market price, transactions, exposed volume, forward positions, hedge rate, target price and portfolio price

show,MSFC-method *S4 method for the show generic for class "MSFC"*

Description

S4 method for the show generic for class "MSFC"

Usage

```
## S4 method for signature 'MSFC'
show(object)
```

Arguments

object	instance of the MSFC class

Value

data frame with daily values for forward curve and forward contracts used in calculation

shpi *Step Hedge Portfolio Insurance (SHPI)*

Description

Implements SHPI strategy for commodity price risk management

Usage

```
shpi(q, tdate, f, daysleft, tper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
daysleft	integer with days left to contract expiry
tper	numeric target price markup/down to the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the SHPI class

Examples

```
# SHPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq (0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum ( sqrt(delta) * rnorm (N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")
```

```
# implement step-hedge strategy for buyer
shpi_b <- shpi(q = 10,
tdate = tr_dates,
f = f_gbm,
daysleft = length(tr_dates),
tper = 0.1,
tcost = 0,
int = TRUE)

# implement step-hedge strategy for seller
shpi_s <- shpi(q = - 10,
tdate = tr_dates,
f = f_gbm,
daysleft = length(tr_dates),
tper = - 0.1,
tcost = 0,
int = TRUE)
```

SHPI-class *An S4 class for the SHPI hedging strategy*

Description

An S4 class for the SHPI hedging strategy

---

slpi *Stop Loss Portfolio Insurance (SLPI)*

Description

Implements SLPI strategy for commodity price risk management

Usage

```
slpi(q, tdate, f, tper, tcost = 0, int = TRUE)
```

Arguments

q	numeric value for quantity to be hedged, either positive (net buyer) or negative (net seller)
tdate	date vector with trading days
f	numeric futures price vector
tper	numeric target price markup/down to the price on the first trading day
tcost	numeric transaction costs pr unit
int	TRUE/FALSE integer restriction on tradable volume

Value

instance of the SLPI class

Examples

```
# SLPI for a buyer (seller), where stop loss is set 10% above (below) initial market price.

set.seed(5)
# GBM price process parameters
mu <- 0.2
sigma <- 0.1
S0 <- 100

# time
Y <- 2
N <- 500
delta <- Y/N
t <- seq (0, 1, length = N + 1)

# price process and date vector
W <- c(0, cumsum ( sqrt(delta) * rnorm (N)))
f_gbm <- S0 * exp(mu * t + sigma * W)
tr_dates <- seq(Sys.Date(), Sys.Date()+500, by = "day")

# implement stop-loss strategy for buyer
slpi_b <- slpi(q = 10,
tdate = tr_dates,
f = f_gbm,
tper = 0.1,
tcost = 0,
int = TRUE)

# implement stop-loss strategy for seller
slpi_s <- slpi(q = - 10,
tdate = tr_dates,
f = f_gbm,
tper = - 0.1,
tcost = 0,
int = TRUE)
```

SLPI-class *An S4 class for the SLPI hedging strategy*

Description

An S4 class for the SLPI hedging strategy

summary,GenericStrat-method *S4 method for the summary generic for portfolio insurance strategy classes*

Description

S4 method for the summary generic for portfolio insurance strategy classes

Usage

```
## S4 method for signature 'GenericStrat'
summary(object)
```

Arguments

object	instance of a strategy class

Value

a list with five elements. 1) A string describing the type of portfolio insurance trading strategy and number of observations, 2) volume to be hedged, calculated churn rate (numer of times volume to be hedged has been traded) and 5) a data frame with summary statistics for achieved results

summary,MSFC-method *S4 method for the summary generic for class "MSFC"*

Description

S4 method for the summary generic for class "MSFC"

Usage

```
## S4 method for signature 'MSFC'
summary(object)
```

Arguments

object	instance of the MSFC class

Value

a list with three elements. 1) A string describing length of forward curve, number of polynomials used in spline and trading date, 2) a vector with a sample of the prior used via head(prior) and 3) a data frame with all forward contracts used in the calculation along with computed forward curve prices

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